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INLAND WATER POLLUTION

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INLAND WATER POLLUTION

A PILOT STUDY OF THE
COMMITTEE ON
THE CHALLENGES OF
MODERN SOCIETY

OCTOBER 1974

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PREFACE

It is recognized that because of its effects on the Environment, the pollution of inland waters is a major threat to the economic and social well-being of the members of the NATO Alliance, as well as to other nations. Because water courses run along or across international frontiers and many river basins are shared by two or more nations, the effects of pollution are felt nationally and internationally, and the resultant problems can only be resolved by national and international actions. NATO may provide a ready forum for negotiating international commitments with which to control the dangers and damages suffered through the pollution of our inland waters.

It is further recognized that whereas each sovereign state can attack the water quality problem within its own borders by application of its own laws and regulattions, control of pollution entering one state from another can only be accomplished by national commitment based on international agreement. Furthermore, new concepts are evolving as nearly all nations, seriously attacking their pollution problem, are developing and adapting their institutions to face this challenge. An opportunity exists for members of the NATO alliance employing different approaches, to learn from each other's experience.

RESOLUTIONS

The member nations of the Alliance agree that

- water quality planning and management are necessary if the present and future needs of mankind are to be assured

They also agree to the principle that

- the urgency of water quality problems and the serious nature of the challenge they pose requires concerted international action in order to safeguard the economic and social well-being of nations

They therefore further agree

- to cooperate actively to attain real and effective water management

RECOMMENDATIONS

The member nations of the Alliance recommend for the achievement of the objective the adoption of four principal areas for action

1. COMPREHENSIVE RIVER BASIN WATER QUALITY PLANNING AND MANAGEMENT
2. INDIRECT INSTRUMENTS IN WATER MANAGEMENT
3. THE USE OF MODELS FOR MANAGEMENT DECISION-MAKING
4. DETERMINATION OF WATER QUALITY OBJECTIVES AND STANDARDS IN INTERNATIONAL WATER COURSES

1. COMPREHENSIVE RIVER BASIN WATER QUALITY PLANNING AND MANAGEMENT

It is recommended that

a) all member nations adopt the river basin (or suitable sub-basins or groups of basins) as the geographic unit for water quality planning and management for water courses flowing entirely within their territory

b) a comprehensive water quality management plan should include full consideration of the scientific, technical, social, economic, financial, and institutional aspects. It should provide for the solution of immediate problems and for future needs

c) because implementation of some projects must proceed during the preparation of a comprehensive plan, care should be taken to ensure that actions do not run counter to the developing plan

d) an early task of water quality planning is the determination of the uses of water, the levels of quality and quantity required for these uses, and a schedule for achieving the objectives.

2. INDIRECT INSTRUMENTS IN WATER MANAGEMENT

Because indirect instruments appear to be particularly effective in Water Quality Management, it is recommended that member nations

a) consider the implementation of appropriate economic instruments such as effluent fees scaled to the size of pollution loads released into water

b) promote public participation in the elaboration of the objectives and in the choice of suitable instruments

c) give consideration to the creation of decentralized basin agencies with sufficient freedom of action to attain the objectives assigned to them

In implementing indirect economic instruments, it is recommended that member nations

d) take special care that the use of such instruments does not introduce competitive advantages in international trade.

3. THE USE OF MODELS FOR MANAGEMENT DECISION-MAKING

It is recommended that:

a) mathematical models be recognized as important and useful instruments for clarifying objectives and predicting results in water quality planning and management.

b) additional research and exchange of knowledge on mathematical modelling be encouraged and supported by member countries in view of the fact that some present models have limited capability.

4. DETERMINATION OF WATER QUALITY OBJECTIVES AND STANDARDS IN INTERNATIONAL WATER COURSES*

When a river basin extends outside the boundaries of a state it is only possible, when formulating recommendations, to deal with the international water courses. In this text an international water course means all boundary and trans-boundary rivers, canals, lakes and estuaries. On this basis, it is recommended that

a) in the management of water quality, international water courses be given the same priority as national water courses

b) water quality objectives for international water courses be developed jointly by the countries involved

c) appropriate formal and informal institutional arrangements be established between countries sharing an international water course to aid in the development of objectives and for planning and managing such water courses to achieve the objectives.

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* *The Netherlands' Authorities wish to make the following observation: the first sentence should be deleted because the restriction which it seems to contain is not in accordance with standing international practice, namely that multi-lateral cooperation deals both with trans-boundary main streams as well as with national water courses, which together form part of the same international basin.*

BACKGROUND ON THE INLAND WATER POLLUTION PROJECT

Pollution of the fresh water resource is a problem of extensive and growing concern in all developed countries. In North America, even the largest lakes and rivers, which little more than a generation ago had scarcely felt the effects of man, have deteriorated rapidly from municipal and industrial pollution and agricultural development. In Europe, historic rivers which have served man for so many centuries are now polluted and the wastes from one nation flow into neighbouring countries. Nor is this a problem of the nations of the North Atlantic Treaty Organization alone; whether in Europe, the Americas, Asia or elsewhere, human concentration and industrial and agricultural development increase the risk of pollution of the water resources.

The effects of water pollution are profound. The impact is apparent not only in the tremendous resources that must be allocated to pollution control programs, but also in the economic impact of lost recreation, fisheries destroyed, the cost of water treatment, and the social and ecological disruptions resulting from deterioration of the environment.

The nature of specific pollution problems are as numerous as the rivers, lakes and groundwater deposits that are affected. However, the pollution exhibited in any water body, in any country, also has a common aspect. It exists because control measures are not adequate. Technology for control can be improved, but the pollution problem is primarily a matter of management. All governments must have effective and efficient water quality management programs within their own boundaries and governments must cooperate in the development of innovative concepts for management of international waters.

The environmental and ecological decay and the attendant social disruption is now one of the greatest threats to the established order in developed countries. Cooperation is required to reach harmony in the effort against the threat of environmental decay. The North Atlantic Treaty

Organization has demonstrated its effectiveness in assuring cooperation between governments to deal with a common challenge. It was felt that the same spirit could be developed to meet the threat of environmental disruption. It is against this background that Canada supported the concept of the Committee on the Challenges of Modern Society and offered to pilot a study on inland water pollution.

In 1969 Canada proposed the Inland Water Pollution Project to the Plenary Session of the CCMS, and the United States, France and Belgium expressed interest in participation within the project. A Program Development meeting was arranged in March 1971 to develop the proposal into a project in which the four countries could work together to the common benefit of all members of the alliance and to advance the cause of improved water quality for all mankind.

It has been the view of Canada that the Inland Water Pilot Project, to be most effective within the context of the CCMS, should have two main goals. It should demonstrate ways in which countries can cooperate in reducing water pollution to their mutual benefit. It should also develop improved techniques and concepts for water quality management that would be of broad interest to member countries in dealing with internal and international problems of freshwater pollution. Hence, in formulating the concept of this pilot proposal, the following precepts were considered:

- the program for the Inland Water Pollution Project should be sufficiently comprehensive to be relevant to national and international management programs;
- Canada should take the lead in developing, initiating and coordinating the pilot study, and co-pilot countries should participate substantially in the design and coordination of the overall program, the conduct of specific aspects, and the preparation of the final report to CCMS;
- emphasis in the Canadian portion of the project should be given to water quality management and particularly to inter-jurisdictional and social dimensions in the

field of water management; co-pilot countries should contribute to the overall project by collaborating in the Canadian portion or by carrying on work complimentary to that being done by Canada;

- the pilot and co-pilot countries at the outset would agree upon a comprehensive plan for developing the project;
- reports should be made to the CCMS from time to time when significant results are achieved. Other interested countries should also be informed;
- the pilot and co-pilot countries should be exploratory and innovative in developing ways of exchanging information, and mutually assisting in program cooperation;
- it is hoped that co-pilot countries would be prepared to contribute time, expertise and other resources to the execution of the project;
- it is considered that scientific and technological research, per se, are more appropriately dealt with by other international organizations.

Canada designated the comprehensive river basin planning and management program for the Saint John River basin as a case study and as a focus for its contribution within the overall Inland Water Pollution Project. The Saint John has the characteristic of being a major international basin and one in which jurisdiction is divided within Canada. Rising in the Province of Quebec and in the State of Maine, the Saint John River flows through the Province of New Brunswick to the sea. It traverses a basin which not only has long established traditions but which also has experienced the impact of urban, industrial and agricultural development. The basin supports a fishery, and is a focus of recreational activity in the area. Pollution in the basin has become a matter of concern to both the United States and Canada.

Canada has emphasized the need for public awareness and support for water quality management plans. Hence it accords particular importance to the role of public participation in the planning process. Canadian authorities were aware that, in many instances, plans had not been translated into action because the planners had failed to recognize fully the needs and desires of the people affected by the plan and because the public in turn may not have been made aware of the full benefit accruing from implementation of the plan. These social considerations in water quality management were considered to be particularly relevant to the intent of the Committee on the Challenges of Modern Society. Efforts to improve this process are fundamental to Canada's approach to water management and of interest to the co-pilot countries. Hence, it was felt that this aspect too should be considered by all countries.

Canada had offered to make provision for full international review of the effectiveness of the program to be developed through federal-provincial joint action on the Saint John basin. Specifically, Canada proposed to demonstrate progress in comprehensive planning and inter-jurisdictional cooperation through a meeting of interested countries. The intent of the program would be presented, and the effectiveness of the program would be tested in workshop sessions among participants from the four countries. The CCMS participants would be asked to explore in depth particular program elements as a means of exploring the value and effectiveness of various policies and programs in water management. The pilot and co-pilot countries agreed to deal with the following program elements:

Canada - Comprehensive River Basin Planning and Management

France - Indirect Instruments in Water Management

United States - Approaches to Water Quality Objectives and Standards in International Basins

Belgium - Role of Models for Management Decision-Making

It was agreed at this time as well that an important aspect of the effectiveness of the Workshop Sessions which were to be carried out in these four subject areas would be the success with which concepts were developed to involve experts from different countries meaningfully in reviews of other national programs. Special emphasis was given in the design and conduct of the Workshop Session in Canada and in the other countries concerned to develop effective and working involvement among scientists and participants concerned. It was felt that the final success of the NATO/CCMS project would depend in large measure on the degree to which pilot and co-pilot countries could move beyond traditional meetings of experts to find new methods to achieve effective participation among specialists from different countries. In this framework, the four countries agreed to exchange experiences in advanced water quality management methods.

COMPREHENSIVE RIVER BASIN PLANNING AND MANAGEMENT

The first workshop session of this Inland Water Pollution Project was the Canadian symposium on comprehensive river basin planning and management. A group of experts from the four countries, together with observers from the Federal Republic of Germany and Portugal, met for the week of September 27 to October 1, 1971, in the city of Fredericton. Fredericton is the capital of the Province of New Brunswick, and is situated on the banks of the Saint John River, which was the focus of the deliberation for this program.

The aims of this symposium were to outline the genesis of the development of the Canadian water management project, to review the experience of Canada and the United States in the Saint John River basin, to discuss the specialized interest of the participating countries in comprehensive planning and public participation, and to foster cooperative activities among interested parties. This was the beginning stage of a process that was designed to lead ultimately to recommendations to member nations of NATO concerning inland water quality management, particularly as it applies to an inter-jurisdictional situation.

The Saint John River

The Saint John River, which provided the central perspective for this meeting, is nearly 700 kilometers long. It rises in the State of Maine and the Province of Quebec, and flows through the province of New Brunswick, part of its length forming the border between Canada and the United States. Approximately 51% of the area of the basin is within New Brunswick, 36% in the State of Maine, and 13% in Quebec. The population within the New Brunswick portion numbers 300,000, in Maine 90,000 and within the Quebec portion of the basin, 60,000. It is not a heavily populated region.

The average rainfall varies from 100-125 cm, which provides a mean flow of approximately 1,100 cubic metres per second at the mouth of the river. The basin has many lakes and tributaries. The lower reaches, extending back some 120 kilometers, are subject to the influence of high tides from the Bay of Fundy.

The dominant industries of the basin are forestry and agriculture, considerable processing of pulp and paper, and food products, some fishing and mining, and commerce through the Port of Saint John. The river has been dammed at a number of points for the production of hydroelectric power. The basin is also a popular resource and recreation area, and is noted for its wildlife.

Processing industries in particular, and communities in varying degrees, pollute the waters of the Saint John River with their effluent. Resource use conflicts are numerous and pollution is severe enough to be detrimental both commercially and socially, and therefore warrants water quality management on the scale intended for this project.

Proceedings

The symposium undertook to review thoroughly basin planning experience in the Saint John River basin. The first stage was to provide to the participants through film, lecture and question periods a complete overview of the progress to date and the intent of the program for the future. A field trip was made through part of the basin to give a first hand impression of both the nature of the problems and their relevance to the planning program being undertaken. The final two days were devoted to workshop sessions, a plenary session and a discussion of further activities needed to complete this CCMS Project.

Background papers had been prepared on the four main components of the symposium, and these were distributed. Each of the topics was assigned to one of the workshops. The four topics (with the lead country indicated) are listed on page 9.

Basin Planning and Management

The background paper emphasized that the basic objective of multipurpose basin planning is to achieve the best use, or a combination of uses, of water and related land resources to meet foreseeable needs

for both the short term and the long term period. This challenge is by no means an easy one, and is made all the more difficult by the division of responsibility for water management in the basin.

Economic development and growth must be achieved consistent with protection of the quality of the water for both recreational and industrial uses. The well-being of all the people should be the over-riding consideration in the planning that is carried forward. To be effective, a water management plan must address three main issues:

- present and future water uses in association with water quality
- pollution abatement to achieve and maintain water quality, and
- institutional arrangements for implementing the plan.

The first step is to identify present and future uses and then to establish minimum water quality objectives for each use. It is possible to incorporate these objectives in legally enforceable water quality standards. The United States experience has shown that the chances for success are poor if only voluntary quality goals are set.

The next step is to identify present and future waste loadings. This information, together with hydrologic data and water quality goals, is sufficient for estimating future treatment needs. Mathematical models and supporting tools are valuable at this stage to fully comprehend the nature of the problem, and determine the degree of treatment required. After the present water quality situation and the sources of pollution are identified, attention can be given to evaluating possible ways of achieving the objectives. These include waste treatment, allocation of discharge points, inter-basin diversion, streamflow regulation, temporary impoundment of wastes, in-stream modification, zoning and control of growth, and combinations of the above.

The final step would be to achieve a least-cost strategy for obtaining the objectives for the basin. The strategy for implementing the plan can be built upon existing institutions and their responsibilities although legislative or institutional changes may be required for effective implementation and control. The resulting plan will guide action through laws and regulations, and must be understood and accepted by the people affected by the plans. The necessary resources must be committed. The regulation and control stage becomes difficult in basins that cross international boundaries. The questions to be resolved with respect to the management system include the kind of authorities it should have, the relationship between water authorities, private firms and public agencies, and the proper allocation of costs and benefits.

Discussion

The discussion pointed out that trade-offs between alternative beneficial uses are difficult enough in a river basin that lies entirely within one jurisdiction, but it becomes much more difficult in the case of the Saint John River, where the basin is shared between two countries, and it may become even more difficult in some of the multi-jurisdictional situations that occur in Europe where rivers may flow successively through three or more nations. The whole scope of the problem associated with management in such a multi-jurisdictional setting was to be taken up in 1972 at the symposium in Maine, U.S.A.

Attention was drawn to difficulties of reconciling the objectives of different water uses, especially with regard to quality and economic growth. If the opinion of certain conservation groups are accepted, almost no water use will be permitted. On the other hand, if the objectives of developers are adopted, little effort for quality control will be made. Choices must be made, and the optimum balance is the one that best reflects the needs and interests of the citizens concerned. Where different countries share a river basin, achieving this balance becomes all the more difficult, and this emphasizes the importance of clear choices defined as objectives and the need for extensive public involvement to select the preferred objectives.

The participants agreed that the most difficult aspect of the planning process was the final implementation. Some alternatives look very good on paper but turn out to be impossible to implement. Financial, political, and social constraints can cut down the number of technical alternatives from which to select. It was agreed that the planning process must include: setting objectives, deciding on an implementation process and outlining a clear procedure to achieve the objectives. The plan must also be economically, environmentally, socially and politically feasible.

The discussion focussed on institutional aspects of planning in an international basin. The Saint John River basin was looked to at some length in this regard. It was noted that neither New Brunswick nor Maine could achieve its objectives if the other side does not undertake a satisfactory program. It was noted that informal working relations such as the types that were being set up between Canada and the United States, and between the Province of New Brunswick and the State of Maine, were extremely important for putting into place a program to which all parties were committed, namely, the improvement of the quality of the water in the Saint John River. In the final stage, formal negotiations may be needed to reach agreement on objectives, standards, schedules and so on.

It was suggested that quite possibly a single organization could serve all the needs of both nations instead of separate international organizations for each river basin. On the other hand, some felt that a single national organization on each side of the border could negotiate standards and objectives for all parts of the basin. There was no final consensus on this point.

The concept of public participation was dealt with at some length in this session. It was noted that it is easier for the planner to proceed without public participation, but public participation is necessary for implementation of a realistic plan. A commitment to public participation within the Canada-New Brunswick program for the Saint John basin was recognized as an important experiment towards making comprehensive basin planning an effective reality.

Other workshops were carried out simultaneously in the areas designated for other national symposia. These workshops likewise developed from background papers that had been presented beforehand. The workshop sessions were informal, and provided valuable in-depth discussion. In particular, the North American participants felt that they were able to learn a great deal from the experience of France in the application of such indirect instruments as effluent charges for waste control. As well, the role of models as a guide to management decision making was explored, and the whole area of standards and objectives in an international basin was the subject of considerable interest and debate among the participants. The discussion in all these areas set the scene for subsequent symposia to be held in each of the three co-pilot countries. The discussions were not conclusive in their exploration of these topics, but outlined areas in which mutual understanding would be of greatest benefit to the participating countries.

The experience of this meeting showed that symposia and workshop sessions of the type carried out in Fredericton were effective tools for cooperative international action on this type of problem. The experience demonstrated that participants and experts from various disciplines, with various points of view, and from the several nations concerned, were willing to participate intensively in discussions directed towards the resolutions of the problems that existed in the Saint John River. Moreover, it was agreed that the workshop approach had great potential for use in other symposia to follow in this inland water pilot project and would undoubtedly be of value to other undertakings of the CCMS.

INDIRECT INSTRUMENTS IN WATER MANAGEMENT

The second seminar of the Pilot Project on Inland Water Pollution of the Committee on the Challenges of Modern Society (CCMS) was held at Pont-à-Mousson, France, May 29 to June 2, 1972. This second seminar addressed itself to the utilization of indirect instruments in water pollution abatement and their application in France.

Objectives were as follows:

1. to promote improved understanding of the water quality management system instituted in France;
2. to enable the participants to exchange experiences based on the policies followed in the countries concerned with this project;
3. to consider the feasibility of applying indirect measures in the various countries within NATO.

The first day covered theoretical principles in water management, presentation of the legislative framework concerning the water regime and distribution, and pollution abatement in France. The application of these principles and of the Water Act (enacted December 16, 1964) were outlined by the presentation of a concrete example: The Rhine-Meuse Basin Financial Agency, its missions, programs and accomplishments.

Visits to water pollution works in the Rhine-Meuse basin were organized for the second day.

These visits enabled participants to obtain a field view of certain pollution problems the agency is facing as well as of techniques adopted in water pollution.

The two following days were devoted to workshops for the study of three indirect instruments in water pollution abatement:

1. levying charges on effluent discharges;
2. financial assistance in pollution abatement;
3. awakening and enlisting the interest of the public.

Three documents prepared in France concerning France's system of water management served as a first approach to problems and as a basis. for workshop discussions.

Finally, the last day, the discussions of the three workshops were reviewed and were terminated with a presentation by France's Department of the Environment.

Rhine-Meuse Basin

Geographical Aspects

The Rhine-Meuse basin located in Eastern France is the second smallest of the six basins in France. It covers 6% of the national territory and includes 8% of France's population. It covers the Rhine basin and its principal tributaries, the Yll and Moselle Rivers--and the Meuse basin.

In its northern section this basin does not have a coastal zone nor a watershed since the main rivers are flowing from south to north in foreign territory.

Three parallel hydrographic units constitute the Rhine-Meuse basin, namely the Meuse and Moselle basins to the west, and the Plain of Alsace to the east, separated by the Vosges mountain range which constitutes a natural "water tower".

Importance of Pollution

Pollution problems are numerous and various. One can particularly mention the problem of the Alsace alluvial aquifer, whose protection is essential since it serves as drinking water supply for a population of one million, or problems posed by chemical industries (the alkali industry), paper mills, steel mills, coal mines, thermal and nuclear-electric power plants, and the food industry (mainly dairying and breweries).

In the whole basin, gross pollution represents the equivalent waste loading of a population of 10 million persons, 4 million of which represent domestic pollution and 6 million, industrial pollution. Having regard to waste water treatment facilities, net pollution discharge into

rivers represents a waste loading equivalent to a population of 7.5 to 8 million. Growth in pollution is approximately 2 to 2.5% per year. This pollution is concentrated within limited areas where water could be rendered unfit for any further uses.

Program of Intervention

The Rhine-Meuse Basin Financial Agency set an objective of eliminating the net pollution in twenty years.

To achieve this, a 5-year intervention program was established by the Agency and approved by the Basin Committee and the Department of the Environment.

The first program 1968-1972, anticipated a total amount of work costing 147.5 million francs of which 48.5 million francs was assistance given by the Agency.

The second program 1972-1976 was based upon the 6th national plan forecasts. Assistance by the Agency (loans and grants) will amount to 118 million francs of a total cost of 245 million francs for the works.

SUMMARY OF DISCUSSIONS

Workshop discussions presented in plenary session outlined the following main conclusions, with particular attention to public participation which was also dealt with in other seminars.

Economic Actions

1. Effluent fees constitute an efficient medium of action for inland water quality management. These are well adapted to the solution of water pollution problems in France. But it is necessary to supplement them with other means such as regulations, especially when it is necessary to prohibit specific forms of pollution (prohibited substances, heavy metals).
2. The fees constitute a medium with which to allocate, between users, the costs of an increased effort in pollution abatement. They do not exclude the utilization of other economic instruments such as fiscal reductions, special amortization for investment expenditures, or grants given by the government in certain cases.
3. Determination of the rate of effluent fees, especially the initial fees, should take account of economic, political, psychological and local conditions. The rate must be high enough to act on the behavior of polluters and to give enough financial resources to basin agencies in order to finance their programs. Successive steps may be necessary to arrive at the desirable rate. The burden of the fees must reflect the effort being made and must be compatible with the economic development plans.
4. The relation that must exist between effluent fee rates and the value of water or the cost of pollution implies a geographical regulating of these rates in terms of the characteristics and objectives for environmental quality. Such regulating must reconcile efficiency with equity.
5. Effluent fee revenues constitute appreciable financial resources to increase the collective and private efforts in pollution abatement. They can be used to finance public works or private installations when these contribute to the achievement of the common goal.

6. As with other pollution abatement expenditures, effluent fees represent an additional charge against production which can not always be compensated by an increase in productivity. The result is a reduction in profit margins or an increase in product prices. So, one must examine the extent to which industries can suppo t the burden of these charges without being too greatly affected in terms of competition, especially for products in international commerce.
7. Some suggestions were made to solve the pollution problems of these industries:
   a) the setting up of a set of minimum standards at the national level to be enforced for every part of an industry in a given country.
   b) the setting up of specific quality objectives (that might be superior to those of minimum standards) in particular regions according to the needs of other water users.
   c) strict implementation of the principle "the polluter must pay" at all levels
   d) financial assistance to certain old enterprises not able to adapt themselves otherwise or to certain enterprises facing severe international competition.
8. Success of the implementation of these fees depends on the coordination of the use of such a medium with the utilization of other direct means of action (regulations). Various provisions were established in France to ensure this coordination within and between various administration levels and between basin agencies and local and central authorities. Thus, to a certain extent, fee implementation and financial assistance provided by these revenues must both urge and help users to be in compliance with regulations.
9. Division of jurisdiction causes important problems in the application of indirect measures, mainly when one considers transboundary rivers (provincial or international), or when responsibilities are divided between central and local authorities. Although these problems are not insurmountable, their complexity increases when there is a large

number of involved parties and when there is a high degree of industrialization. International rivers in Europe such as the Rhine, and the Great Lakes in North America, are good examples of this.

10. Generally, if pollution of a river flowing in several countries is a matter of concern, coordination of policies should be sought to achieve objectives set jointly. This coordination does not imply limitations in the choice of methods by the concerned countries. However it seems desirable to match the costs to the users, which might in turn bring agreement on the instruments to be used.

Public Participation

At Pont-à-Mousson public involvement was recognized as an indirect method of bringing pressure to bear on polluters to act in good faith with the authorities. It was seen as reinforcing the other indirect methods: effluent charges and incentive programs. For this reason an entire workshop session was devoted to this subject.

There was wide agreement that all aspects of water quality control, from planning to regulations, affect the general public both economically and socially. Therefore the general public has the right to be heard, and in fact its more voluble members will make themselves heard. The question that faced the delegates was not whether there should be involvement, but how it should be organized and coordinated with the planning and management processes. On this subject there was wide divergence of opinion. Several methods were recognized as perhaps of equal efficiency in gauging public value judgements-hearings, referenda, the ballot box, opinion polls, attitude surveys and direct involvement in the planning and management processes.

In France, the principle of decentralized decision-making and of public and private user participation was embodied in the Act which created the agences financieres de bassin (basin financial agencies).

Public involvement is necessary for the operation of the agencies which collect fees from water users to finance the basin plans. Representatives of the public participate in the decision-making process. The agencies attempt to establish a dialogue with the public in order to determine future directions and options which are in keeping with the public's preferences.

Methods used are:

- the written and oral press
- dissemination of information documents (pamphlets, brochures, magazines, etc.)
- organization of information and discussion meetings dealing with specific cases at the local level.

Determining future directions and objectives of a water management policy has given rise to "Livres Blancs" on river basins. These documents are statements of problems and policies and are prepared following many consultations with experts and discussions within all interested representative bodies.

It was agreed that much remains to be learned about the relative validity of these various techniques. Research and testing are needed to evaluate them better, but it seems likely that there is no universal formula. There are, however, certain principles that are general and should be closely followed regardless of the methodology selected for involvement of the public in a particular issue, place and time. These are:

1. Everyone is a member of the public including industrialists, elected representatives and civil servants. A public participation program should avoid placing the general public on one side and officialdom on the other.
2. Everyone is a water user and, where conflict exists among users, society, through its employees and elected representatives, may have to allocate rights among the antagonists.

3. If the general public is to participate usefully in such decisions the real alternatives must be clearly defined. To make this possible the public must be given the facts, unblemished and unequivocally expressed in plain language. Great care must be taken in preparing material for public information.
4. If it is the policy to involve large numbers of people, meetings should be scheduled at appropriate intervals in order to give the largest number of persons the opportunity to participate.
5. Decision models can be used to inform the public on the complexities of the institutional, ecological and economic interdependencies that will be affected by an apparently simple decision. Also advertising and public relations campaigns may be useful to alert the public to the extreme sensitivity of the environment at certain critical periods, and thus to minimize costly accidental spills, etc., at these times.

In the United States great reliance is placed on statutory hearings relating to proposed projects, while in Canada, a number of methods have been applied, from a system rather like the French one which was used in the Qu'Appelle basin, to the Saint John River program which was directed towards involvement of a large segment of the general public at all key stages of plan development (see section on Basin Planning).

Conclusions

In the seminar held in Pont-à-Mousson the theoretical approach came face to face with the practical realities of a concrete case.

This showed that all the problems may not be solved and that additional adaptations are still necessary to ensure the optimal efficiency of indirect instruments in water quality management.

It also underlined the necessity of public involvement because the public is directly involved in this type of action. The best way to achieve this is to seek and consider public advice and preference in the decision-making process.

The delegates also insisted on the need for reaching international agreements on pollution abatement for industries subject to severe international competition and also on the necessity for harmonization of policies concerning transboundary pollutions.

Generally, the continual bringing forward of experiences by each country can only contribute to a mutual enrichment and favour a better understanding of the pollution problems each country is facing.

APPROACHES TO WATER QUALITY OBJECTIVES AND STANDARDS IN AN INTERNATIONAL BASIN

The third international workshop symposium of the Inland Water Pollution Project of the North Atlantic Treaty Organization's Committee on Challenges of Modern Society, was held September 18-22, 1972 at Fish River Lake near Portage, Maine, U.S.A. During the meetings delegates from six alliance countries considered the subject of "Approaches to Water Quality Objectives and Standards in an International Basin". The experts investigated alternative international institutional arrangements to assist countries in combatting pollution in river basins and lakes shared by nations.

A computer model of a portion of a hypothetical international river basin was employed at the symposium to demonstrate the complexities involved in decision-making at national, regional and local levels of government. In three half-day sessions delegates were assigned various decision-making roles and the results of their decisions were computerized and assessed for effectiveness.

During the seminar sessions, the experts discussed alternative institutional arrangements for water quality management. A summary of the several views of the participants was presented in the closing sessions for use in making recommendations to CCMS on possible international approaches to attack pollution in international waters. In addition, the heads of the pilot and co-pilot delegations met on Wednesday, September 20, to schedule future project activities.

The Computer Game

The computer game was played with an existing urban model, modified especially for this symposium to include international water quality considerations. The hypothetical "Two Country River Basin" is shared by two nations. The population of the area is about 275,000. Country 2 has several industries dumping large volumes of pollutants into rivers which then flow into Country 1. Country 2 also has a high unemployment rate, and both residents and government are encouraging industrial expansion. Country 1

has few low-income residents and no unemployment. Its residents are concerned about the pollution caused by the industries in Country 2 and have in the past opposed industrial growth upstream.

In general, living conditions are better in Country 1. The schools are fairly good, the parks are excellent, and police and fire protection is adequate. In Country 2 the level of government services is much lower and parkland is almost non-existent in the lower-income residential sections. However, in Country 2 the river water quality is excellent; in Country 1 it is so bad that it is not usable for any purpose.

"Two Country" is a hypothetical area, but the conditions and conflicts existing in the area are analagous to many real-world situations. The participants in the conference were the decision-makers in"Two Country". The decisions were of the high-level type, a computer program performing the more detailed functioning of the area in response to the decisions made and policies set by the participants. Each "round" (i.e. cycle of decision-making) represented a year in the life of the represented area. Thus, the decision-makers could see the effects of their decisions over time.

The total resources of "Two Country" were controlled by participants, but each participant controlled resources of only one of three general types: economic, social, or government. Furthermore, a participant could control resources in only one of the two countries.

The actions of each decision-maker affected many other decision-makers and their concerns in the simulated region. For example, the decision to build a new industry increased the number of jobs available, created new demands for local suppliers of industrial needs, altered the tax base, changed the use of local utilities and water, etc. which are of concern to other participants.

In each of the sessions, one simulation game was played. In each year of the simulation the participants prepared budgets, and were allowed to negotiate agreements. In the first two rounds, a lack of cooperation between competing factions led to further degradation of the water quality situation. However, by the third round, the participants began to reach workable compromises such as loans between industries, agreements between municipalities etc., and the water quality began to show improvement.

The model provided a useful tool for postulating alternative management processes, and examining institutional structures as to their suitability in dealing with typical interjurisdictional water quality programs. It also provided the participants with useful insights into the complex interrelationships between the multiplicity of decision making bodies typically involved in solving real-world problems.

Seminar Sessions

Three seminar sessions were held to discuss institutional problems and needs, and the nature of desirable international institutional arrangements for water quality management. The first session was a presentation of the highlights of the background papers,"International Institutions for Water Quality Management", and "Factors to Consider in the Design of Institutions". In the latter paper, six propositions were put forward. These propositions provided the basis for discussion in the second part in which conference participants were divided into two groups. Finally, the general session reconvened to discuss the conclusions reached in the separate sessions.

The sessions resulted in a frank and lively exchange of views on the six propositions. The points raised and considered were not the same in both groups and the conclusions reached on the specific propositions differed in some respects.

Joint Agreement of Canada and U.S. on Measures to Enhance Water Quality in the Saint John River

An agreement between the Governments of Canada and the United States on joint measures to cooperate in water quality planning and to devise needed programs to enhance the water quality of the Saint John River and its tributaries was jointly announced at the Maine Workshop Symposium.

Officials of the two countries agreed to establish a U.S. - Canada Committee on Water Quality for the Saint John River and its international tributaries. Composed of representatives of federal, state, provincial and local governmental agencies, the Joint Committee will review progress in conducting water quality planning in the Saint John River basin

in both countries. It will also exchange information on plans, programs, and actions which would affect water quality in the basin; assist in coordination and consultation among appropriate authorities; and make recommendations to the appropriate jurisdictions on water quality in the basin.

The announcement was made by L. Edgeworth, Assistant Deputy Minister, Water Management Service of Canada's Department of the Environment, and Fitzhugh Green, Associate Administrator for International Affairs of the U.S. Environmental Protection Agency.

The Canada - U.S. action was timely for the symposium, which was considering alternative institutional arrangements for dealing with water pollution between countries. Application of Canada - U.S. decision is expected to demonstrate the effect of one such approach to solving transboundary water pollution problems, and it will be evaluated within the framework of the CCMS Inland Water Pollution Pilot Project.

Conclusions

In the course of the investigation of approaches to water quality objectives and standards in an international basin, it was possible to draw a number of important conclusions which commend themselves to other nations confronting similar problems. Among these were the following:

1. The development and implementation of an effective and efficient international pollution control program generally or of a specific water pollution program requires the countries involved to reach agreement on water quality objectives and standards for the international or transboundary waters.

Agreed objectives or standards are the common goals. While they are the first essential step for agreement in dealing with a transboundary problem, they may take time to arrive at and thus may proceed in parallel with other actions nations might take to deal with the transboundary pollution problem, such as contingency plans for oil and hazardous materials spills. The water quality objectives should be stated initially in general terms with a view to moving toward more specific objectives as

information and agreement is achieved. The establishment of objectives and standards must be understood to be a continuing process which is affected and changed by new information and understanding, and new legislation, financing and program development, but they are the key to solving an international water quality problem.

11. Agreed water quality objectives and standards should be developed early in the water quality management planning process in an international basin as they are the primary and essential guideline for such planning.

To devise and implement water quality uses, criteria and implementation plans in an international framework requires agreement on the basic goal. Early agreement on the goal will facilitate accomplishment of the steps needed to reach the objectives or standards.

111. The internationally agreed objectives and standards must be developed simultaneously by the participating countries and they should be based upon consideration of the planned uses of the land and waters within the drainage basin, the pollution causes and the measures needed to correct the pollution problem.

The successful agreement by countries on objectives and standards in almost every instance will depend upon the countries involved agreeing or understanding each others' views on the following steps needed to establish standards:

- determination of the water uses to be protected;
- establishment of water quality criteria for supporting the designated uses;
- identification of the pollution sources or causes of the pollution;
- determination of the pollution control measures needed to clean up pollution;
- implementation schedules, including enforcement authority, financing and construction needed for clean-up and;
- surveillance and overview to insure that the agreed actions are achieving the agreed objectives.

The need to accomplish these steps simultaneously cannot be over-emphasized. There is no way to achieve international objectives of standards except through agreement, for there is no legal authority to force nations to comply with water quality goals. The final agreement can be achieved most successfully when the parties involved mutually accept each of the required actions. For example, it would be extremely difficult to achieve agreed international objectives and standards if the countries involved did not agree on the pollution causes or on the water's intended uses, and similarly with the other steps.

IV. To the extent feasible and possible, water quality objectives and standards should take cognizance of national goals and policies of the respective governments concerned with the international or trans-boundary waters and reflect those that are achievable and mutually acceptable.

It is a fact of international life today that sovereign governments hold primary responsibility for making decisions and taking actions to control environmental pollution. This is likely to remain the case for years to come even though some international organizations will attain increasing responsibility in this field.

Additionally, it is also true that the authority to deal with environmental problems in some countries resides in state, provincial, and local, rather than national governments. Consequently, before international agreement can be achieved, agreement between governmental authorities within individual countries frequently is needed. Unless common goals and policies are attained in the process of establishing objectives and standards, a final agreement will be difficult to achieve at the international level.

V. Consideration should be given to establishing appropriate institutional arrangements for aiding countries to develop internationally-agreed objectives and standards, as well as for planning and eventual management of international basins to achieve such objectives and standards.

In most instances existing institutions do not provide machinery for implementing the various steps necessary to achieve agreed international objectives and standards, particularly where international and regional, (in contrast to global) pollution problems are involved. Hence new institutional arrangements frequently are needed. In particular, four steps in the process of establishing international objectives and standards lend themselves to institutional handling, as follows:

- initial agreement by governments to seek common objectives and standards which is a political decision involving policy-level officials;
- development of factual background information on sources and causes of pollution, intended water uses, establishment of criteria and identification of alternative control measures, which are technical decisions involving water pollution control and planning officials;
- decision on alternative control measures to be employed, a political decision by policy-level officials; and
- overview responsibilities to ascertain that progress is being made toward accomplishment of the objectives, usually a technical-level responsibility.

To the extent possible existing institutions should be used to undertake these tasks, but in many instances new arrangements will be required.

VI. In devising institutional machinery to assist governments in developing objectives and standards, careful attention should be given to ensuring that the institution's responsibilities and its membership are such as to assure achievement of the objectives and standards.

The responsibilities outlined in the Item V above suggest areas where new institutions may be needed; it also points up the responsibility and types of individuals needed to accomplish the tasks involved. It is clear from this delineation of authorities that the primary implementation responsibility for pollution control measures will remain in the hands of the respective governments. International institutions can perform many other functions such as information exchange, coordination, planning, development of recommendations, provision of overview and surveillance.

and the like. They can even spur governmental action and exert moral pressure. But in most instances they will not have adequate implementing authority. This important role can and should be carried out by sovereign governments.

Appropriate membership is essential to proper functioning of the institutions; where technical level decisions must be made, technical officials should be involved. Where policy decisions are required, political officials should participate.

Where possible the international institutions should directly involve the responsible officials of the governments involved in every step of the process for developing objectives and standards. For example, governmental authority for objective and standard development and implementation and for general management should be included in the process on the international level. Only in this way can governments ensure that the agreed objectives and standards will be acceptable and will be implemented. If this work is done by officials without the authority to implement, the likelihood of acceptance and implementation of the objectives or management plan will be markedly reduced.

Also, thought must be given to the balance in membership among the nations participating in the new institution. While various numbering arrangements can certainly be devised, experience shows that to the extent possible, equal national representation on joint bodies is preferable, and individual nations should make their own decisions on the desired distribution between federal, state and local authorities on its delegation.

WORKSHOP ON MATHEMATICAL MODELLING

Sixty experts on inland water quality from twelve countries met in Brussels, Belgium, from May 21 to May 25, 1973 to discuss the formulation of mathematical models for inland waters, and the role of models in water quality management decision-making. Mr. Charles Hanin, Belgian Minister of Science Policy, who presided over the opening session, stressed the importance of the problem of inland water pollution and the urgent need for finding solutions to it.

The workshop sessions covered two general themes. The first theme was scientific, and focussed mainly on the Belgian modelling effort on the Sambre River, which is scheduled for completion in 1975. Separate workshop sessions were held on biology, chemistry, and the integration of sub-models into a comprehensive, or global model. The second theme on the role of models was sub-divided into three sessions: the role of models in water quality planning; the role of water quality models in comprehensive basin planning, and; the role of models in policy formulation.

Scientific Sessions

The scientific sessions began with a general discussion of the Belgian "Program of Research and Development on the Physical and Biological Environment", followed by a more detailed description of the Sambre River modelling studies. The total program has five projects; mathematical modelling of the coastal Sea; mathematical modelling of rivers; environmental technology; vulnerability of groundwater, and; cost-benefit methodology.

The Sambre River is the scene of the river modelling effort in Belgium. The basic objective of the work is the definition of the residual-purifying capacity of the various reaches of the river, and expression of this self-purifying capacity in a dynamic model, expressing at the same time the evolution of the aquatic "system". The project was initiated on July 1, 1971, and is being carried out by about 100 research workers.

The sessions concluded with a description of each of the five modelling studies considered in the Sambre River investigations:

1. Elementary Hydraulic Model
2. Elementary Nitrification Model
3. Elementary Oxygen Model
4. Elementary Biological Model
5. General Model.

In the biology sessions, introductory statements questioned the validity of many of the available techniques. Models based on first order kinetics were considered lacking because they fail to account for changes in biomass. Problems are caused because nitrification and biodegradation occur in sequence rather than simultaneously. The kinetics of photosynthesis requires the choice of an initial germination which varies according to season. The destiny of the synthesized biomass after destruction by pollution is another problem, as is the choice of a typical pattern of light penetration. The feasibility of including the macro fauna as a separate factor in a biomass model requires more research.

Discussions within the Biology group centred on the following issues:

1. The feasibility of expressing the results from various sub-groups (microbiology, algology, macrobiology) in the same units was debated. Extensive discussions took place on the advantages and disadvantages of dry weight (corrected by the weight of the ashes), calorific value, enzymatic productivity, etc. as appropriate measures. The main problem with most parameters, particularly in polluted rivers, is that of measuring only living matter.

The concensus of opinion appeared to be that dry weight reduced by the weight of the ashes is probably the most promising common measure, especially since it is closely tied to calorific content. These measurements can be made conveniently and with a relatively high level of accuracy. However, there are still major problems in measuring the energy flux through the system, and in defining the dynamics of the renewal of biomass, the rates of which are different by several orders of magnitude according to the biological groups considered.

2. The accuracy of basic data was discussed. Sampling and the measurement itself are the two sources of error. In most cases, reproducibility of individual measurement is possible. Sampling error is therefore considered to be the major source of uncertainty.

3. Discussion took place on the various sub-models, which constitute a global biomass model. One item not included in present models, but considered important in the benthos and periphyton, is the mycological sector, which requires more study.

4. The participants then discussed the various types of models used in ecology. The problem with these models is that they either address only closed systems, or are too theoretical. The initial phase of the Belgian research on this subject has provided considerable insight into the problems involved, and has lead to the conclusions that any refinement will have to be accompanied by laboratory research.

5. Regarding comprehensive biological models, the concensus appeared to be that the integration of biological sub-models can be accomplished by using a global biological model describing the trophic pyramid, and "autecological" models describing the behavior and the interactions of specific animal and bacterial populations.

The chemistry sessions raised several points regarding the study of liquid-solid interactions, and problems related to certain chemical analyses.

a) Study of solid-liquid interactions·

In order to study the influence of urban and industrial effluents on a river it is obviously necessary to know the physico-chemical and chemical characteristics of the various phases - the aqueous phase (water) and the solid phase (sediments and matter in suspension). However, one should keep in mind that pollution of a river is a dynamic process:

- Pollutant loads vary with time as a result of the presence of a fauna and flora that is more or less active in destroying these different pollutants. It has been shown for instance that some pollutants such as phenols and cyanides are degraded

very quickly (even in highly polluted waters) under certain biological conditions. The problem is then to determine the nature of the eventual residues that cannot be biologically degraded any further.

Other pollutants - among them heavy metals - pass very quickly from the aqueous to the solid phase through absorption on the suspended matter which is then deposited and constitutes the ooze (the study of this ooze can reveal a great deal about the history of a river). On the other hand sediments may be brought back in suspension and certain pollutants dissolved anew due to the effect of high tides, passing boats, etc.

These examples clearly indicate the importance of understanding the kinetics of the passage of matter from one phase to the other.

b) Problems related to certain chemical analyses:

- determination of trace elements
- interferences
- determination of the nature of certain organic pollutants
- specificity of methods (for a number of pollutants - phenols, hydrocarbons, detergents - it is only possible at the present time to determine an overall index and not the percentage of a single specific element)
- the time required (in some instances, it is essential to adopt simple and rapid analytical methods).

When these problems are overcome, it is also necessary to ensure that results from different laboratories are compatible, so as to be assured that results obtained are truly representative.

During the discussions, representatives from the various countries described progress in their respective agencies. The emphasis in these discussions was on the relationship between water quality and water uses. There was also considerable discussion on the choice of chemical parameters for consideration, and sampling strategy.

The final scientific session provided an opportunity for the participants to reassess the Belgian modelling effort in the light of discussions which had taken place earlier in the chemistry and biology sessions. It was concluded that the hydrologic and nitrification studies were well in hand, and that the areas which require substantial additional research include the kinetics of reaeration, sedimentation, biodegradation, and photosynthesis. The Belgians also expressed the intention of adding socio-economic considerations to their overall modelling effort. This would include population, and industrial growth sub-models.

Sessions on the Role of Models

The sessions on the role of models were introduced with a number of questions, including:

1. When should we and when should we not use mathematical models?
2. What should we expect to obtain from using models?
3. Which models should we use?
4. How do we decide which models we should use?
5. How comprehensive or simple should they be?
6. How much will they really cost?
7. How do we decide the benefits from conducting the modelling exercise?
8. How do we use several models interactively?

The theme of the first session was the role of models in water quality planning, specifically the role of models in the U.S. water pollution control program. The U.S. control program is being implemented by the individual states and will involve controlling all point sources to prescribed levels, with more stringent requirements being applied in areas where in-stream standards would be violated with the general effluent standards in place. A national program of issuing permits based on a combination of effluent and water quality standards is underway for some 50,000 industrial and 15,000 municipal sources.

Standards for each industrial sector are based on best practicable technology and are defined in terms of effluent output per ton of product produced. Municipal requirements are for secondary treatment. Water quality standards for intra-state waters are in the process of being defined by the states and, where acceptable to the Environmental Protection Agency, are being implemented. Federal standards as legislated by congress apply to inter-state waters and in all other areas where state defined standards are not available.

About two years ago, EPA initiated the development and calibration of water quality models for 26 major basins, generally based on the steady-state Streeter-Phelps formulation (first order kinetics). Three of the models address the eutrophication problem directly and others include parameters such as heavy metals, temperature, and coliform organisms where required for planning purposes. The intention is to use the models in cost effectiveness studies, for example to examine the alternative of relocating industries rather than providing a very high level of treatment, and for setting effluent requirements in areas where the general effluent standards are insufficient to meet water quality standards. An interesting observation emerging from these studies is that even though large volumes of water quality data have been collected, the proper types of data required for the modelling-planning function are seldom available.

Discussion centred mainly on three general topics. Firstly, the advantages and disadvantages of the effluent-water quality standards approach as opposed to the effluent fee concept and the role of models in each approach were debated at some length with no general consensus emerging. Secondly, a lively discussion ensued about the usefulness of optimization models in water quality planning. The U.S. experience has been disappointing in this area due to a lack of accurate cost data, communication problems, and the fact that institutional arrangements are seldom available to implement the so-called optimal solution. Several other delegates were somewhat more optimistic about the potential of these techniques.

Other topics briefly touched upon included equity considerations between industries in different countries, non-point sources of pollution, the validity of first order kinetic models, the feasibility of developing standards based on regional economic considerations, and the objectives of the Belgian modelling program.

During the summing up, the role of the public in the water quality decision-making process was discussed and it was observed that perhaps one of the most positive aspects of modelling is its tendency to focus public attention on particular problem areas.

In the session on the role of models in comprehensive planning, the planner's view of the role of models in comprehensive basin planning was presented. The planner was described as a bridge between the modeller and the politician. It was stressed that, as in the use of maps, models too must be used within the limits of their capabilities, and can only be used intelligently if we know where we are and where we want to go.

The Canadian experience in the Saint John River basin was described in considerable detail. Some of the more useful lessons derived from the experience include:

1. Someone who is intimate with the real-life system (a user) should be on the modelling team.
2. The model has been very effective for sensitivity analysis to test the response of the river system to ranges of values of input parameters.
3. Other conditions and contaminants are often as important as or more important than these originally modelled because we tend to include what has been modelled before rather than what we are really interested in.
4. A good model should be continuously updated and work on it should never be finished.

5. Results depend very much on interpretation and are of no real value to anyone who does not know the system, the data limitation, etc.
6. A steady-state water quality model is difficult if not impossible to calibrate since steady-state conditions never really occur.

Discussions in this session focussed initially on data requirements. Considerable data are normally required for proper calibration of mathematical models. However, it was noted that it is often useful to proceed with a modelling effort based on limited data. By using existing data and supplementing it with rough approximations based on experience and recorded information in other similar watersheds, the modelling exercise can provide a useful assessment of the relative importance of various types of data. Using the information generated by the model, appropriate emphasis can be given to specific data collection requirements.

Regarding techniques, it was generally considered that a greater problem existed with the relative lack of knowledge of in-stream processes than with mathematical techniques. On optimization models, most use an economic efficiency function for their objective. However, equity considerations can be built into such models, either as constraints or as a companion part of the optimizing functions.

There appeared to be some consensus that modelling exercises have become too complex. There are great benefits in starting the planning exercise with a relatively simple screening approach. It was also noted that models are often perceived as being too technocratic. Mathematical modellers have often been at fault here, basically due to their own inability to translate concepts into clear, readily understandable prose.

The third workship session, on the role of models in policy formulation, was focused on two topics.

1. Role of models in policy formulation and evaluation.
2. Real use of models in planning and decision-making.

The first topic was introduced with policy being defined as "the framework within which action decisions are made". Such policies can range from the political through all levels of administration. Two examples of model application to policy formulation were given. The first, in the Saint John River basin, evaluated differences between policy based on equity and that based on efficiency. The result showed a significant difference, with the equity policy costing three times as much as the efficiency policy. The second example was on the Pecos River system in which growth and investment were forecast as well as expected decisions and time lag of the manager to effectuate decisions. This example demonstrated the difficulty of acceptance of policies formulated through usage of a model.

Three questions were then posed for group discussion as follows:

1. What is the potential for use of models in setting water quality standards?
2. Where else have models been used in policy evaluation? Particularly, what was the French experience in establishing effluent charges?
3. Should political processes be included in comprehensive models?

Summary of discussion on these questions indicated that in most situations to date, models have not been used in policy formulation or evaluation mainly because clean water has not been scarce enough to require such evaluation.

In the U.S., a model was used in the Delaware basin for setting standards, but this stage has now been passed and standards have been essentially legislated. The French have not used models in either standard setting or the establishment of effluent charges, but may use them soon in evaluating the present system of charges. There has been only very limited application of models to standard setting in international basins. Possibly the most relevant type of model for that purpose would be gaming models. Discussion was closed with the suggestion that since the status of the use of models in policy formulation was similar for all, we might consider their value in analyzing alternative choices and to afford better communication between decision makers and the public.

Discussion of the second topic - "Real use of models in planning and decision making" - was preceded by a general classification of model types according to management perception and to technical perception. A brief outline of the planning process was followed by an example of using models to improve the learning process.

The discussion produced several general conclusions as follows:

1. With such a wide range of model types, it is considered best to define at the outset the planning objective and decide early when to use models in the process and for what purpose.
2. In using models in the planning process, proceed from the simple to the complex.
3. Models can be useful as a communication link between the planning process, and public perception and acceptance of plans.
4. Care should be exercised in the use of models so as not to deliberately bias decisions. This requires teamwork and similar motivation between the planner and modeller.

CONCLUSIONS

Representatives from the four countries met during the week of September 24-28, 1973 in Ottawa, Canada to consider conclusions and recommendations, and to prepare this final report on the Pilot Project.

The initial goals of the project were: 1) to demonstrate ways in which countries can cooperate in reducing water pollution to their mutual interest and; 2) to develop improved techniques and concepts for water quality management that would be of broad interest to member countries in dealing with internal and international problems of freshwater pollution. In meeting these objectives, the four countries have gained a greater understanding of the theory and practice of water quality management under their several jurisdictions and, in some instances, are already beginning to adopt one another's approaches for their own use.

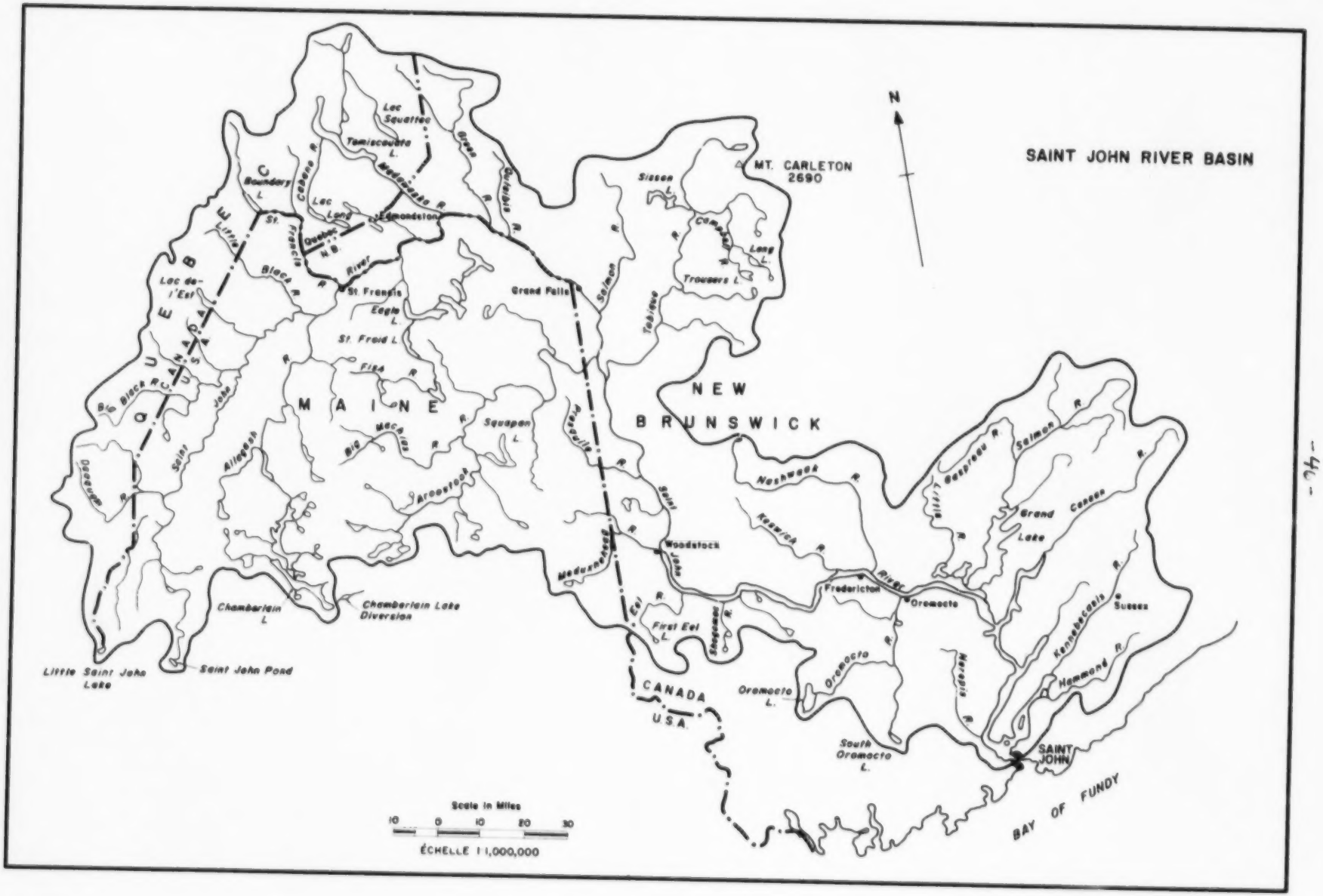
A significant factor contributing to the success of the overall project was the in-depth consideration of ongoing planning and management activities in the four countries, such as the Rhine-Meuse Financial Agency in France, the Sambre River mathematical modelling studies in Belgium, and the Saint John River planning efforts in Canada and the United States. One of the highlights of the project was an agreement between the Canadian and United States Governments on joint measures to cooperate in water quality planning and to devise needed programs to enhance the water quality of the Saint John River and its tributaries. This agreement was jointly announced at the Maine Symposium.

The project demonstrated that although national techniques for dealing with the control and abatement of water pollution in international river basins may vary from country to country, there is considerable similarity in approaches and problems. In these areas, it is clear that cooperative measures between and among countries dealing with international river basin pollution problems could be useful and, in some instances essential.

In reviewing the areas of comprehensive basin planning and management, development and use of water quality objectives and standards, indirect management instruments and use of models, a number of areas for common approaches and collaboration among countries become evident. Such approaches and cooperation, it was found, could usefully be fostered in (1) identifying and (2) assessing the pollution problems, (3) establishing water quality criteria, (4) determining the alternative control and abatement programs which might be undertaken to deal with them, conducting (5) research, (6) monitoring and surveillance and (7) establishing the needed institutional arrangements for conducting these activities internationally.

A number of suggested means for incorporating these techniques and activities into the international approaches to water quality management in an international river basin are included in the project resolutions and recommendations.

The interchange of views has proven of value to the pilot and co-pilot countries, and it is hoped that other member nations will also benefit.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Saint John R.
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Big Machias R.
Squapan L.
Aroostook R.
Chamberlain L.
Chamberlain Lake Diversion
Little Saint John Lake
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Tobique R.
Sisson L.
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LA MOSELLE
ÉPINAL
COLMAR
MULHOUSE
ALTKIRCH
LE RHIN
BASEL